

Application No. 10/721,464
Reply to Office Action of February 7, 2007

IN THE CLAIMS

Please amend the claims as follows:

Claim 1 (Currently Amended): A method of confirming a battery charge amount and degradation state, comprising:

a first step of measuring or calculating at a plurality of battery temperatures a cycle test battery in respect of battery internal and outside surface temperatures and one selected from battery open voltage, current and voltage during discharge, and current and voltage during charging at prescribed time intervals substantially until an end of life of the cycle test battery;

a second step of using measured or calculated values to generate a determination table showing relationships between charge amounts and degradation states at said prescribed time intervals;

a third step of measuring or calculating a subject battery in respect of said battery internal and outside surface temperatures and said one selected from battery open voltage, current and voltage during discharge, and current and voltage during charging; and

a fourth step of comparing determination table values with said battery internal and outside surface temperatures and at least one measured or calculated value of the subject battery to make a primary confirmation of a present subject battery charge amount and degradation state in accordance with a determination table location of matching values and to make an overall confirmation of results of the primary confirmation based on an appearance ratio of said determination table location, thereby estimating said present subject battery charge amount and degradation state, wherein the first step comprises any one of (i) a calculation of a direct current resistance BZ of the cycle test battery from a formula: $BZ = (B2v1 + B2v2 + , \dots , + B2vn) / [(B3i1 + B3i2 + , \dots , + B3in) / n]$, in which B2v1 to B2vn individually denote a battery voltage during constant current discharge, n denotes an integer

of 2 or more and is applicable subsequently and B3i1 to B3in individually denote a discharge current measured at fixed time intervals, (ii) a calculation of a rate of discharge voltage decrease BRT from a formula: $BRT = (B2v1 - B2vn) / [tb1 \times (n - 1)]$, in which tb1 denotes a fixed time interval, (iii) a calculation of a return-up voltage BU following termination of discharge from a formula: $BU = B4vn' - B2vn$, in which B4vn' denotes a return battery voltage measured ultimately after termination of discharge and n' denotes an integer of 2 or more and is applicable subsequently, (iv) a calculation of a ratio BURT of the return-up voltage following the termination of discharge from a formula: $BURT = (B4vn' - B2vn) / [tb2 \times (n' - 1)]$, in which tb2 denotes a fixed time interval after return, (v) a measurement of a time C2 to lower the voltage to a predetermined optional value varying depending on at least one of a kind of batteries and rating in constant-current constant-voltage discharge, (vi) a measurement of discharged currents C3i1, C3i2, ..., C3in at a constant time interval tc1 from the time C2 in constant-current constant-voltage discharge, (vii) a calculation of a rate of current decrease CRT from a formula: $CRT = (C3i1 - C3in) / [tc1 \times (n - 1)]$, (viii) a calculation of a direct current resistance DZ from a formula: $DZ = D1vn / D1in'$ obtained through measurements of charge voltages D1v1, D1v2, ..., D1vn and of charge currents D1i1, D1i2, ..., D1in made when changing a current at constant time intervals, (ix) a measurement of a time E2 to charge voltage to a predetermined constant value varying depending on at least one of a kind of batteries and rating in constant-current constant-voltage charging, (x) a measurement of discharge currents E3i1, E3i2, ..., E3in changed at a constant time interval te1 from the time E2 in the constant-current constant-voltage charging, and (xi) a calculation of a rate of charge current decrease ERT from a formula: $ERT = (E3i1 - E3in) / [te1 \times (n - 1)]$.

Claim 2 (Canceled).

Claim 3 (Original): The method according to claim 1, in which a value of the battery open voltage is an average value of measurements made at fixed time intervals.

Claim 4 (Canceled).

Claim 5 (Original): The method according to claim 1, in which the measurement of the voltage and current during discharge in a constant current discharge circuit comprises the steps of:

measuring battery voltage;

after discharge starts, measuring battery voltage a plurality of times at fixed time intervals;

measuring discharge current a plurality of times at fixed time intervals simultaneously with the step of measuring battery voltage a plurality of times; and

after terminating the discharge, measuring battery voltage a plurality of times at fixed time intervals.

Claim 6 (Canceled).

Claim 7 (Original): The method according to claim 1, in which the measurement of battery voltage and current during discharge, and a measurement of time, in a constant current, constant voltage discharge circuit comprise the steps of:

measuring battery voltage;

subtracting a predetermined voltage from the measured battery voltage to set a constant voltage discharge value;

measuring a time from a start of the discharge until the set constant voltage discharge value is attained;

after the start of the discharge, measuring discharge current a plurality of times at fixed time intervals; and

terminating the discharge.

Claim 8 (Canceled).

Claim 9 (Original): The method according to claim 1, in which the measurement of current and voltage during constant current charging comprises the steps of:

measuring battery voltage;

after the step of measuring the battery voltage, starting the charging and measuring battery voltage when the charge current is changed a plurality of times at fixed time intervals;

measuring the charge current when the charge current is changed a plurality of times at fixed time intervals; and

terminating the charging.

Claim 10 (Canceled).

Claim 11 (Original): The method according to claim 1, in which the measurement of current and voltage, and a measurement of time, during constant current, constant voltage charging comprise the steps of:

measuring battery voltage;

adding a predetermined voltage to the measured battery voltage to set a constant voltage charging value;

starting the charging after setting the constant voltage charging value;
measuring a time at which the set constant voltage charging value is attained;
measuring the charge current a plurality of times at fixed time intervals; and
terminating the charging.

Claim 12 (Canceled).

Claim 13 (Original): The method according to claim 1, in which ambient temperature during the step of measuring the cycle test battery to generate the determination table and during the step of measuring the subject battery, is measured a plurality of times at fixed time intervals.

Claim 14 (Canceled).

Claim 15 (Original): The method according to claim 3, in which ambient temperature during the step of measuring the cycle test battery to generate the determination table and during the step of measuring the subject battery, is measured a plurality of times at fixed time intervals.

Claim 16 (Canceled).

Claim 17 (Original): The method according to claim 5, in which ambient temperature during the step of measuring the cycle test battery to generate the determination table and during the step of measuring the subject battery, is measured a plurality of times at fixed time intervals.

Claim 18 (Canceled).

Claim 19 (Original): The method according to claim 7, in which ambient temperature during the step of measuring the cycle test battery to generate the determination table and during the step of measuring the subject battery, is measured a plurality of times at fixed time intervals.

Claim 20 (Canceled).

Claim 21 (Original): The method according to claim 9, in which ambient temperature during the step of measuring the cycle test battery to generate the determination table and during the step of measuring the subject battery, is measured a plurality of times at fixed time intervals.

Claim 22 (Canceled).

Claim 23 (Original): The method according to claim 11, in which ambient temperature during the step of measuring the cycle test battery to generate the determination table and during the step of measuring the subject battery, is measured a plurality of times at fixed time intervals.

Claim 24-79 (Canceled).